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Name: Linda McCormick



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- ☒ Utility Patent Application: Spec. 13 pgs; 8 claims; Abstract 1 pgs.:
- ☒ 3 sheets of formal drawings
- ☒ Certified copy of a Republic of Korea application, Serial No. 1999-42860, filed October 5, 1999, the right of priority of which is claimed under 35 U.S.C. 119
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RADIO FREQUENCY RECEIVER FOR CDMA MOBILE COMMUNICATION BASE STATION SYSTEM

BACKGROUND OF THE INVENTION

5 1. Field of the Invention

The present invention relates to a radio frequency (RF) receiver for a code division multiple access (CDMA) mobile communication base transceiver station (BTS) system and, more particularly, to an RF receiver for a CDMA mobile communication BTS system contrived to down-convert RF signals of 3 FA's to
10 intermediate frequency (IF) signals, convert the 3FA IF signals to digital signals, and digitally perform the FA-based QPSK demodulation and channel filtering.

2. Description of the Related Art

A general CDMA mobile communication BTS system is composed of a switching system and cell equipment. Here, the system is constituted by a plurality of
15 functional devices which are implemented with various forms of equipment.

The nucleus of the mobile communication BTS system is implemented with a digital self embedding a channel card, a sector interface card, an analog common card and a terminal card, and a transceiver self for up-converting an IF signal output from the digital self to an RF signal, or down-converting the RF signal to the IF signal.

20 The transceiver self also embeds a sector interface card for combining the forward baseband signals received from the channel card and up-converting the combined signals to IF signals. The sector access card combines the baseband transmission signals received from the analog common card and amplifies the combined signals. The combined signals are passed through a low-pass filter (LPF)
25 into IF signals, i.e., the signals are combined with 0° or 90° delay signals of 4.95 MHz

and sent to an RF rack as IF signals of 4.95 MHz via a band-pass filter (BPF). The RF rack converts the IF signals of 4.95 MHz to RF signals.

Now, a description will be given to a general CDMA digital mobile communication BTS system with reference to Fig. 1.

5 Fig. 1 is a schematic block diagram of the general CDMA digital mobile communication BTS system.

As illustrated, the CDMA digital mobile communication BTS system includes:
a BTS control processor (BCP) 2 for entirely managing and controlling a BTS; a BTS
interconnection network (BIN) 3 for performing the function of a packet router
10 between the BTS and a base station controller (BSC) 1 via a line E1 or T1, and
interfacing high-level data link control (HDLC) packet data between the respective
processors provided in the BTS; a time and frequency unit (TFU) 4 for generating a
reference frequency and a timing sync signal to acquire synchronization between the
respective processors in the BTS and timing synchronization with neighboring BTS's;
15 a digital unit (DU) 5 for modulating/demodulating data and voice signals
communicated via CDMA channels; and an RF unit (RFU) 6 for converting an RF
signal received from a mobile station to an IF signal, transmitting the IF signal to the
DU 5, converting the IF signal received from the DU 5 to the RF signal and
amplifying the RF signal to a predetermined level for spatial distribution. Here, the
20 RFU 6 is divided into an RF transmitter for converting the IF signal to the RF signal
and transmitting the RF signal to the mobile station via an antenna, and an RF receiver
for converting the RF signal received from the mobile station to the IF signal.

The RF receiver according to prior art will now be described in further detail
with reference to Fig. 2.

Fig. 2 is a schematic block diagram of the RF receiver for the CDMA mobile communication BTS system according to prior art, which includes two antennas 10 and 15 to attain diversity, FA-based RF down-converters 30, 31 and 32, FA-based analog IF units 40, 41 and 42, and FA-based channel cards 50, 51 and 52.

5 The RF receiver supporting antenna diversity has two physical reception paths of “0” and “1”. The first antenna 10 and a first receive block 20 are assigned to the reception path of “0”, the second antenna 15 and a second receive block 25 assigned to the reception path of “1”.

10 All the first, second and third RF down-converters 30, 31 and 32 and the first, second and third analog IF units 40, 41 and 42 have two blocks for independently processing the reception paths of “0” and “1” and support both the reception paths of “0” and “1”.

15 The first and second antennas 10 and 15 and the first and second receive blocks 20 and 25 are used in common to all FA’s assigned, and the first to third RF down-converters 30, 31 and 32 and the first to third analog IF units 40, 41 and 42 are used by FA’s.

20 The first, second and third channel cards 50, 51 and 52 are provided at least one in number and used by FA’s. For example, the RF receiver for the CDMF system supporting 4 FA’s has two antennas, two receive blocks, four RF down-converters, and four analog IF units, and thus includes at least four channel cards.

Now, a description will be made as to an operation of the above-structured RF receiver supporting 3 FA’s according to prior art.

First, the first and second receive blocks 20 and 25 receive RF signals from the first and second antennas 10 and 15, respectively, limiting the band of the signal using

a band-pass filter (not shown), and amplify the band-pass filtered signals to a predetermined level with a linear noise amplifier (not shown). The first and second receive blocks 20 and 25 then output the amplified RF signals, i.e., the RF signals on the reception paths of “0” and “1”, respectively, to the first, second and third RF down-converters 30, 31 and 32.

The first, second and third down-converters 30, 31 and 32 receive the RF signals on the reception paths of “0” and “1” from the first and second receive blocks 20 and 25, down-convert the received RF signals to IF signals with a two-stage mixer (not shown) and a local oscillator (not shown) and output the converted IF signals to the FA-based first, second and third analog IF units 40, 41 and 42.

That is, each of the first, second and third RF down-converters 30, 31 and 32 first down-converts the RF signals to IF signals of about 70 MHz via the local oscillator and the mixer provided at the first stage and second down-converts the IF signals of the 70 MHz to IF signals of the 4.95 MHz via the local oscillator and the mixer provided at the second stage, concurrently limiting the band of the signals with an SAW filter having a passband of 1.25 MHz that corresponds to the bandwidth of one FA.

Each of the first, second and third analog IF units 40, 41 and 42 by FA’s receives the IF signals of corresponding FA’s on the reception paths of “0” and “1” output from the FA-based first, second and third RF down-converters 30, 31 and 32, divides the IF signals into I (In-phase) and Q (Quadrature) channels, down-converts the I/Q channel IF signals to a baseband to perform quadrature phase shifting keying demodulation, and A/D converts the I/Q channel analog baseband signals to digital baseband signals.

The FA-based analog IF units 40, 41 and 42 multiplex the I/Q channel digital baseband signals on the reception paths of “0” and “1” and transmit them to the channels cards 50, 51 and 52 corresponding to the respective FA’s.

5 The FA-based channel cards 50, 51 and 52 receive the multiplexed I/Q channel digital baseband signals on the reception paths of “0” and “1” to perform CDMA demodulation by FA’s.

As the conventional RF receiver for the CDMA mobile communication BTS system uses RF down-converters and analog IF units by FA’s, the system can be expanded by no more than one FA during FA expansion.

10 Therefore, in order to process multiple FA’s, for example, 3 FA’s, there are needed to provide three RF down-converters and three analog IF units with a consequence of increased size of the RF receiver and hence the BTS system, thus raising the hardware cost.

Furthermore, the RF receiver has a limitation on reducing the size of the board
15 due to a need of two mixers in the RF down-converter.

SUMMARY OF THE INVENTION

It is, therefore, an object of the present invention to provide an RF receiver for a CDMA mobile communication BTS system contrived to simultaneously down-
20 convert RF signals of 3 FA’s to IF signals, convert the 3FA IF signals to digital signals and then digitally perform the FA-based QPSK demodulation and channel filtering, thereby reducing the size and hardware cost of the RF receiver and allowing multi-expansion of the FA’s.

To achieve the above object of the present invention, there is provided an RF

receiver for a CDMA mobile communication base station system, which has a plurality of receive blocks for receiving RF signals via a plurality of antennas, and a plurality of FA-based channel cards, the RF receiver including: an analog down-converting converter for down-converting multi-FA RF signals on the respective
5 reception paths output from the plural receive blocks to IF signals; and a digital down-converter for converting the IF signals of 3 FA's on the respective reception paths output from the analog down-converter to digital signals by reception paths, dividing the digital signals into I and Q channels of the FA's on the respective reception paths to down-convert the digital signals to I/Q channel baseband signals, and generating the
10 FA-based I/Q channel baseband signals to the channel cards corresponding to the respective FA's.

In another aspect of the present invention, there is provided an RF receiver for a CDMA mobile communication base station system, which has two receive blocks for receiving RF signals via two antennas, and FA-based channel cards, the RF receiver
15 including: an analog down-converter for down-converting multi-FA RF signals on first and second reception paths output from the two receive blocks to IF signals; two analog-to-digital converters for converting the down-converted IF signals on the first and second reception paths from the analog down-converter to digital signals; FA-based digital units on the first and second reception paths for dividing the digital
20 signals output from the two analog-to-digital converters into FA-based I and Q channels on the first and second reception paths to perform QPSK demodulation, and down-converting the I/Q channel digital signals to baseband signals; and a multiplexer for multiplexing the first and second reception paths and the I/Q channel baseband signals on the first and second reception paths output from the FA-based digital units

and generating the multiplexed digital signals to the channel cards corresponding to the respective FA's.

BRIEF DESCRIPTION OF THE DRAWINGS

5 Fig. 1 is a schematic block diagram of a general mobile communication BTS system;

 Fig. 2 is a schematic block diagram of an RF receiver for a CDMA mobile communication BTS system according to prior art; and

 Fig. 3 is a schematic block diagram of an RF receiver for a CDMA mobile
10 communication BTS system according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

 Hereinafter, preferred embodiments of an RF receiver of a CDMA mobile communication BTS system according to the present invention will be described in
15 detail with reference to the accompanying drawings.

 Fig. 3 is a schematic block diagram of the RF receiver for the CDMA mobile communication BTS system according to the present invention.

 As illustrated, the RF receiver comprises: first and second antennas 10 and 15; first and second receive blocks 20 and 25 for receiving RF signals of 3 FA's from a
20 mobile station on distinct paths, i.e., reception paths of "0" and "1", limiting the band of the 3FA RF signals, and amplifying the 3FA RF signals to a predetermined level; an analog down-converter 60 for down-converting the RF signals of 3 FA's to 3FA IF signals; and a digital down-converter 70 for converting the 3FA IF signals on the reception paths of "0" and "1" from the analog down-converter 60 to digital signals by

FA's, dividing the digital signals into I and Q channels by FA's on the reception paths to down-convert the I/Q channel digital signals to baseband signals, and generating the I/Q channel baseband signals by FA's to first, second and third channel cards 50, 51 and 52.

5 The analog down-converter 60 comprises: a local oscillator (not shown) for generating a local frequency on the reception paths of "0" and "1"; a mixer (not shown) for mixing the local frequency from the local oscillator with 3FA RF signals on the reception paths of "0" and "1" from the first and second receive blocks 20 and 25 and generating 3FA IF signals on the reception paths of "0" and "1"; and a
10 wideband SAW filter (not shown) for limiting the band of the 3FA IF signals on the reception paths of "0" and "1" from the mixer to a bandpass whose bandwidth corresponds to the bandwidth of 3 FA's.

 The IF frequency on the reception paths of "0" and "1" is about 70 MHz and the bandwidth of the SAW filter is 3.75 MHz corresponding to the 3 FA's. The reason
15 why the bandwidth for 3 FA's is 3.75 MHz lies in that a gap between the FA's amounts to 1.25 MHz.

 The digital down-converter 70 comprises: A/D converters 71 and 72 on the reception paths of "0" and "1" for converting the band-limited IF signals from the analog down-converter 60 to digital signals; FA-based DU's 73 to 78 on the reception
20 paths of "0" and "1" for dividing the digital signals from the A/D converters 71 and 72 into the FA-based I/Q channels for QPSK demodulation and down-converting the digital signals of I/Q channels to baseband signals; and a multiplexer 9 for FA-based multiplexing the baseband signals of I/Q channels on the reception paths of "0" and "1" from the FA-based DU's 73 to 78 and generating the multiplexed baseband signals

to the first, second and third channel cards 50, 51 and 52 corresponding to the 3 FA's.

The baseband signals output from the DU 73 are I/Q channel baseband signals of 0FA on the reception path of "0", the baseband signals from the DU 74 are I/Q channel baseband signals of 1FA on the reception path of "0", and the baseband signals from the DU 75 are I/Q channel baseband signals of 2FA on the reception path of "0".

Similarly, the baseband signals output from the DU 76 are I/Q channel baseband signals of 0FA on the reception path of "1", the baseband signals from the DU 77 are I/Q channel baseband signals of 1FA on the reception path of "1", and the baseband signals from the DU 78 are I/Q channel baseband signals on 2FA on the reception path of "1".

The QPSK demodulation unit in the individual DU's 73 to 78 comprises: a channel divider (not shown) for dividing the digital signals from the A/D converters 71 and 72 into I and Q channels; a local oscillator (not shown) for generating a local frequency; a mixer for mixing the local frequency from the local oscillator with the I and Q channel signals divided at the channel divider and converting the mixed signals to I/Q channel baseband signals; and a digital FIR filter (not shown) for filtering the reception paths and the FA-based I/Q channel baseband signals from the mixer and generating the band-limited baseband signals to the multiplexer 79.

Now, a description will be made as to an entire operation of the above-structured RF receiver for the CDMA mobile communication BTS system according to the present invention.

First, the first and second receive blocks 20 and 25 receive 3FA RF signals for the reception paths of "0" and "1" from the antennas 10 and 15, respectively.

The first and second receive blocks 20 and 25 limit the signal band with the internal band-pass filters and amplify the signals with a linear noise amplifier, generating the amplified signals to analog down-converter 60.

5 The antenna 10 and the first receive block 20 are assigned to the reception path of “0”, the antenna 15 and the second receive block 25 assigned to the reception path of “1”. The antennas 10 and 15 and the first and second receive blocks 20 and 25 are used in common to all FA’s assigned.

10 The analog down-converter 60 embeds two distinct blocks processing the reception paths of “0” and “1”, respectively, and supports both the reception paths of “0” and “1”.

15 The analog down-converter 60 receives the 3FA RF signals for the reception paths of “0” and “1” from the first and second receive blocks 20 and 25, down-converts them to IF signals of about 70 MHz using a single-stage mixer, and generates the IF signals to the A/D converters 71 and 72 corresponding to the reception path of “0” and “1” of the digital down-converter 70.

20 Namely, as the 3FA RF analog signals for the reception path of “0” from the first receive block 20 are input to the mixer in the analog down-converter 60 that processes the signals on the reception path of “0”, the mixer mixes the 3FA RF signals from the first receive block 20 with the local frequency from the local oscillator to down-convert the 3FA RF signals to IF signals of 70 MHz. The down-converted IF signals of 70 MHz are band-limited with the SAW filter having a bandpass of 3.75 MHz that corresponds to the bandwidth of 3 FA’s, and then output to the A/D converter 71 of the digital down-converter 70.

Meanwhile, upon receiving the 3FA RF analog signals for the reception path of

“1” from the second receive block 25, the mixer in the analog down-converter 60 for processing the signals on the reception path of “1” mixes the 3FA RF signals from the second receive block 25 with the local frequency from the local oscillator to down-convert the 3FA RF signals to IF signals of 70 MHz. The down-converted IF signals of 5 70 MHz are band-limited with the SAW filter having a bandpass of 3.75 MHz that corresponds to the bandwidth of 3 FA’s, and then output to the A/D converter 72 of the digital down-converter 70.

Thus the IF signals on the reception paths of “0” and “1” from the analog down-converter 60 are converted to digital signals at the first and second A/D 10 converters 71 and 72 of the digital down-converter 70 and input to the two groups of three DU’s 73, 74 and 75, and 76, 77 and 78, which are assigned by the reception paths of “0” and “1”.

That is, the A/D converter 71 corresponding to the reception path of “0” outputs the IF digital signals on the reception path of “0” to the FA-based DU’s 73, 74 15 and 75, the A/D converter 72 corresponding to the reception path of “1” generating the IF digital signals on the reception path of “1” to the FA-based DU’s 76, 77 and 78.

The DU’s 73, 74 and 75 divide the digital signals of 0FA, 1FA and 2FA output from the A/D converter 71 on the reception path of “0” into I- and Q-channel signals, perform QPSK demodulation to down-convert the digital signals to I- and Q-channel 20 baseband signals, limit the band of the I- and Q-channel baseband signals for the respective FA’s via a digital FIR filter, and generate the I- and Q-channel baseband signals for the respective FA’s to the multiplexer 79.

The DU’s 76, 77 and 78 divide the digital signals of 0FA, 1FA and 2FA output from the A/D converter 72 on the reception path of “1” into I- and Q-channel signals,

perform QPSK demodulation to down-convert the digital signals to I- and Q-channel baseband signals, limit the band of the I- and Q-channel baseband signals for the respective FA's via a digital FIR filter, and generate the I- and Q-channel baseband signals for the respective FA's to the multiplexer 79.

5 That is, the DU 73 outputs I/Q channel baseband signals of 0FA on the reception path of "0", the DU 74 I/Q channel baseband signals of 1FA on the reception path of "0", the DU 75 I/Q channel baseband signals of 2FA on the reception path of "0".

10 Similarly, the DU 76 outputs I/Q channel baseband signals of 0FA on the reception path of "1", the DU 77 I/Q channel baseband signals of 1FA on the reception path of "1", the DU 78 I/Q channel baseband signals of 2FA on the reception path of "1".

15 The multiplexer 79 multiplexes the I/Q channel baseband signals of 0FA on the reception path of "0" output from the DU 73 and the I/Q channel baseband signals of 0FA on the reception path of "1" from the DU 76 to generate the multiplexed signals to the first channel card 50 corresponding to 0FA.

20 The multiplexer 79 multiplexes the I/Q channel baseband signals of 1FA on the reception path of "0" output from the DU 74 and the I/Q channel baseband signals of 1FA on the reception path of "1" from the DU 77 to generate the multiplexed signals to the second channel card 51 corresponding to 1FA.

 The multiplexer 79 multiplexes the I/Q channel baseband signals of 2FA on the reception path of "0" output from the DU 75 and the I/Q channel baseband signals of 2FA on the reception path of "1" from the DU 78 to generate the multiplexed signals to the first channel card 52 corresponding to 2FA.

The I/Q channel baseband signals corresponding to the respective FA's output from the multiplexer 79 are CDMA demodulated at the channel cards 50, 51 and 52 by FA's.

Accordingly, instead of the conventional RF down-converters and analog IF unit, the RF receiver for the CDMA mobile communication BTS system according to the present invention comprises the analog down-converter for processing multiple FA's and generating IF signals of 70 MHz having a bandwidth corresponding to the multiple FA's with a mixer, and the digital down-converter for digitally processing the respective FA's through A/D conversion of the IF signals of 70 MHz, thereby allowing simple multi-FA(3FA)-based expansion.

As described above, the RF receiver for the CDMA mobile communication BTS system according to the present invention presents some advantages in that: (1) the system can be expanded by multiple FA's (e.g., three FA's) during FA expansion by using an analog down-converter to processes multiple FA's and generate IF signals of 70 MHz having a bandwidth corresponding to the multiple FA's with a mixer, and a digital down-converter to digitally process the respective FA's through A/D conversion of the IF signals of 70 MHz; (2) the system needs only one analog down-converter for simultaneously processing 3 FA's and one digital down-converter for digitally processing the IF signals from the analog down-converter by FA's to down-convert the IF signals to baseband signals, thereby reducing the size of the system and hence the hardware cost; and (3) the system can be implemented with higher stability by digitally processing the down-conversion of the analog IF signals of multiple FA's to the baseband signals.

WHAT IS CLAIMED IS:

1. A radio frequency (RF) receiver for a code division multiple access (CDMA) mobile communication base station system, which has a plurality of receive
5 blocks for receiving RF signals via a plurality of antennas, and a plurality of FA-based channel cards, the RF receiver comprising:

an analog down-converting means for down-converting multi-FA RF signals on the respective reception paths output from the plural receive blocks to intermediate frequency (IF) signals; and

10 a digital down-converting means for converting the IF signals of 3 FA's on the respective reception paths output from the analog down-converting means to digital signals by reception paths, dividing the digital signals into in-phase (I) and quadrature (Q) channels of the FA's on the respective reception paths to down-convert the digital signals to I/Q channel baseband signals, and generating the FA-based I/Q channel
15 baseband signals to the channel cards corresponding to the respective FA's.

2. The RF receiver as claimed in claim 1, wherein the analog down converting means comprises:

a local oscillator on the individual reception paths for generating a local
20 frequency;

a mixer on the individual reception paths for mixing the local frequency generated from the local oscillator with the multi-FA RF signals on the individual reception paths output from the plural receive blocks to generate multi-FA IF signals on the individual reception paths; and

an SAW filter on the individual reception paths for limiting the band of the multi-FA IF signals on the individual reception paths output from the individual mixer to the bandpass of a bandwidth corresponding to the multi-FA bandwidth.

5 3. The RF receiver as claimed in claim 2, wherein the multiple FA's are 3 FA's, the IF frequency on the individual reception paths of "0" and "1" is 70 MHz, and the bandwidth of the SAW filter is 3.75 MHz corresponding to the 3 FA's.

10 4. The RF receiver as claimed in claim 1, wherein the digital down-converting means comprises:

an analog-to-digital converter on the individual reception paths for converting the IF signals output from the analog down-converters to digital signals;

15 a FA-based digital unit on the individual reception paths for dividing the digital signals output from each analog-to-digital converter into the FA-based I/Q channels on the individual reception paths to perform QPSK demodulation and down-converting the I/Q channel digital signals to I/Q channel baseband signals; and

a multiplexer for multiplexing the reception paths and the I/Q channel baseband signals output from the FA-based digital unit and generating the multiplexed digital signals to the channel cards corresponding to the respective FA's.

20

5. The RF receiver as claimed in claim 4, wherein the digital unit comprises:

a first reception path 0FA digital unit for converting the digital signals output from the analog-to-digital converter corresponding to the first reception path to the I/Q

channel baseband signals assigned to 0FA;

a first reception path 1FA digital unit for converting the digital signals output from the analog-to-digital converter corresponding to the first reception path to the I/Q channel baseband signals assigned to 1FA;

5 a first reception path 2FA digital unit for converting the digital signals output from the analog-to-digital converter corresponding to the first reception path to the I/Q channel baseband signals assigned to 2FA;

a second reception path 0FA digital unit for converting the digital signals output from the analog-to-digital converter corresponding to the second reception path to the I/Q channel baseband signals assigned to 0FA;

a second reception path 1FA digital unit for converting the digital signals output from the analog-to-digital converter corresponding to the second reception path to the I/Q channel baseband signals assigned to 1FA; and

a second reception path 2FA digital unit for converting the digital signals output from the analog-to-digital converter corresponding to the second reception path to the I/Q channel baseband signals assigned to 2FA.

6. The RF receiver as claimed in claim 4, wherein the individual FA-based digital unit comprises:

20 a channel divider for dividing the digital signals output from the analog-to-digital converter on the corresponding reception paths into I and Q channels for QPSK demodulation at the digital unit on the respective reception paths;

a local oscillator for generating a local frequency;

a mixer for mixing the local frequency generated from the local oscillator with

the divided I/Q channel signals to convert the I/Q channel signals to I/Q channel baseband signals; and

a digital FIR filter for band-pass filtering the respective reception paths and the FA-based I/Q channel baseband signals output from the mixer and generating the
5 band-limited baseband signals to the multiplexer.

7. The RF receiver as claimed in claim 4, wherein the multiplexer multiplexes:

the I/Q channel baseband signals output from the first reception path 0FA
10 digital unit and the I/Q channel baseband signals output from the second reception path 0FA digital unit;

the I/Q channel baseband signals output from the first reception path 1FA digital unit and the I/Q channel baseband signals output from the second reception path 1FA digital unit; and

15 the I/Q channel baseband signals output from the first reception path 2FA digital unit and the I/Q channel baseband signals output from the second reception path 2FA digital unit, and

generates the multiplexed signals to the channel cards corresponding to the respective FA's.

20

8. An RF receiver for a CDMA mobile communication base station system, which has two receive blocks for receiving RF signals via two antennas, and FA-based channel cards, the RF receiver comprising:

an analog down-converter for down-converting multi-FA RF signals on first

and second reception paths output from the two receive blocks to IF signals;

two analog-to-digital converters for converting the down-converted IF signals on the first and second reception paths from the analog down-converter to digital signals;

- 5 FA-based digital units on the first and second reception paths for dividing the digital signals output from the two analog-to-digital converters into FA-based I and Q channels on the first and second reception paths to perform QPSK demodulation, and down-converting the I/Q channel digital signals to baseband signals; and

- a multiplexer for multiplexing the first and second reception paths and the I/Q
10 channel baseband signals on the first and second reception paths output from the FA-based digital units and generating the multiplexed digital signals to the channel cards corresponding to the respective FA's.

ABSTRACT OF THE DISCLOSURE

The RF receiver for the CDMA mobile communication BTS system according to the present invention realizes the system with an analog down-converter to process multiple FA's and generate IF signals of 70 MHz having a bandwidth corresponding to the multiple FA's with a mixer, and a digital down-converter to digitally process the
5 respective FA's through A/D conversion of the IF signals of 70 MHz, allowing simple multi-FA(3FA)-based expansion.

Also, the system needs only one analog down-converter for simultaneously processing 3 FA's and one digital down-converter for digitally processing the IF
10 signals from the analog down-converter by FA's to down-convert the IF signals to baseband signals, thereby reducing the size of the system and hence the hardware cost. The system can be implemented with higher stability by digitally processing the down-conversion of the analog IF signals of multiple FA's to the baseband signals.

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FIG. 1

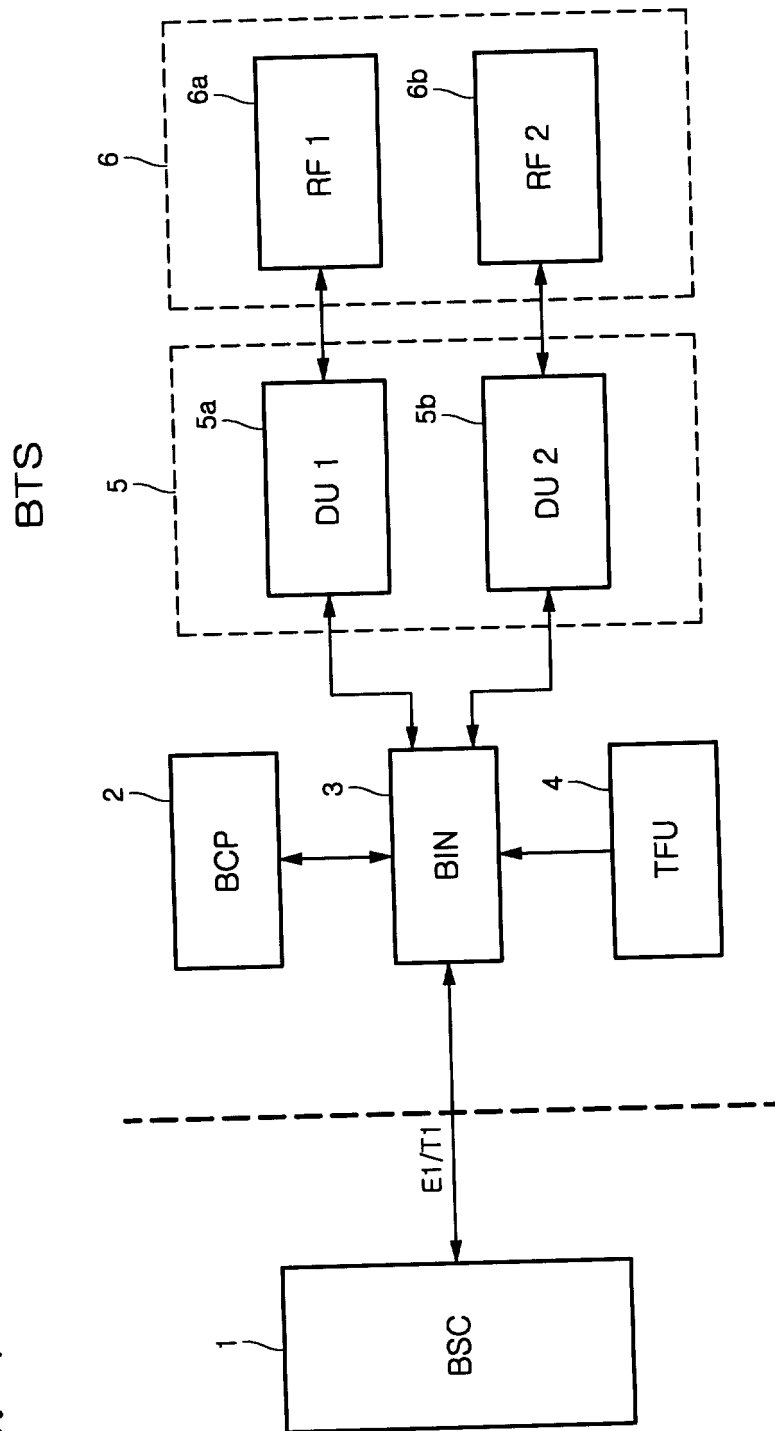


FIG. 2

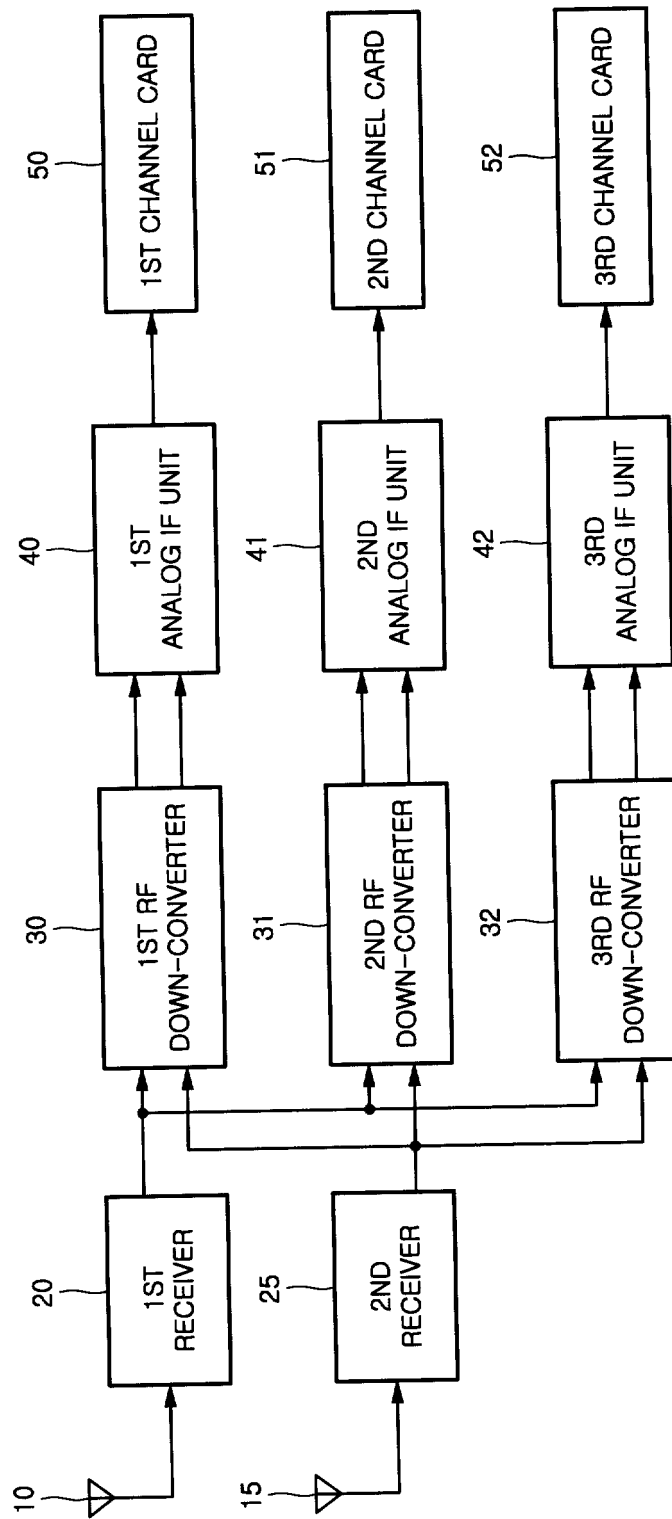
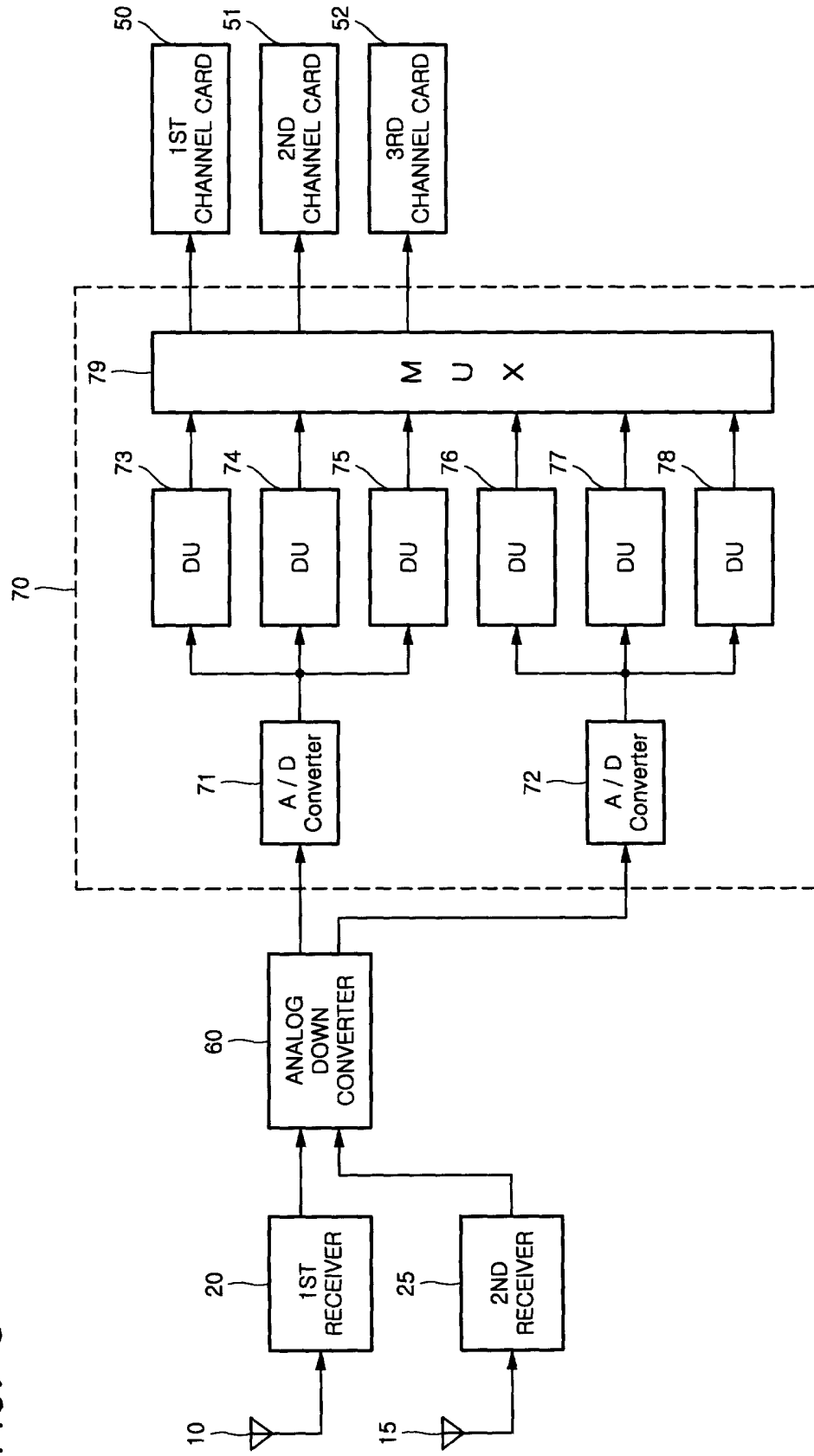


FIG. 3



MERCHANT & GOULD P.C.

United States Patent Application

COMBINED DECLARATION AND POWER OF ATTORNEY

As a below named inventor I hereby declare that: my residence, post office address and citizenship are as stated below next to my name; that

I verily believe I am the original, first and sole inventor (if only one name is listed below) or a joint inventor (if plural inventors are named below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: RADIO FREQUENCY RECEIVER FOR CDMA MOBILE COMMUNICATION BASE STATION SYSTEM

The specification of which

- a. ☒ is attached hereto
b. ☐ was filed on _____ as application serial no. _____ and was amended on _____ (if applicable) (in the case of a PCT-filed application) described and claimed in international no. _____ filed _____ and as amended on _____ (if any), which I have reviewed and for which I solicit a United States patent.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, § 1.56 (attached hereto).

I hereby claim foreign priority benefits under Title 35, United States Code, § 119/365 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on the basis of which priority is claimed:

- a. ☐ no such applications have been filed.
b. ☒ such applications have been filed as follows:

FOREIGN APPLICATION(S), IF ANY, CLAIMING PRIORITY UNDER 35 USC § 119			
COUNTRY	APPLICATION NUMBER	DATE OF FILING (day, month, year)	DATE OF ISSUE (day, month, year)
Republic of Korea	1999-42860	October 5, 1999	
ALL FOREIGN APPLICATION(S), IF ANY, FILED BEFORE THE PRIORITY APPLICATION(S)			
COUNTRY	APPLICATION NUMBER	DATE OF FILING (day, month, year)	DATE OF ISSUE (day, month, year)

I hereby claim the benefit under Title 35, United States Code, § 120/365 of any United States and PCT international application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, § 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. APPLICATION NUMBER	DATE OF FILING (day, month, year)	STATUS (patented, pending, abandoned)

I hereby claim the benefit under Title 35, United States Code § 119(e) of any United States provisional application(s) listed below:

U.S. PROVISIONAL APPLICATION NUMBER	DATE OF FILING (Day, Month, Year)

I hereby appoint the following attorney(s) and/or patent agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected herewith:

Albrecht, John W.	Reg. No. 40,481	Leon, Andrew J.	Reg. No. P-46,869
Ali, M. Jeffer	Reg. No. 46,359	Leonard, Christopher J.	Reg. No. 41,940
Anderson, Gregg I.	Reg. No. 28,828	Liepa, Mara E.	Reg. No. 40,066
Batzli, Brian H.	Reg. No. 32,960	Lindquist, Timothy A.	Reg. No. 40,701
Beard, John L.	Reg. No. 27,612	Lycke, Lawrence E.	Reg. No. 38,540
Berns, John M.	Reg. No. 43,496	McAuley, Steven A.	Reg. No. 46,084
Black, Bruce E.	Reg. No. 41,622	McDonald, Daniel W.	Reg. No. 32,044
Branch, John W.	Reg. No. 41,633	McIntyre, Jr., William F.	Reg. No. 44,921
Bremer, Dennis C.	Reg. No. 40,528	Mitchem, M. Todd	Reg. No. 40,731
Bruess, Steven C.	Reg. No. 34,130	Mueller, Douglas P.	Reg. No. 30,300
Byrne, Linda M.	Reg. No. 32,404	Nichols, A. Shane	Reg. No. 43,836
Campbell, Keith	Reg. No. P-46,597	Pauly, Daniel M.	Reg. No. 40,123
Carlson, Alan G.	Reg. No. 25,959	Phillips, Bryan K.	Reg. No. P-46,990
Caspers, Philip P.	Reg. No. 33,227	Phillips, John B.	Reg. No. 37,206
Chiapetta, James R.	Reg. No. 39,634	Plunkett, Theodore	Reg. No. 37,209
Clifford, John A.	Reg. No. 30,247	Prendergast, Paul	Reg. No. 46,068
Daignault, Ronald A.	Reg. No. 25,968	Pytel, Melissa J.	Reg. No. 41,512
Daley, Dennis R.	Reg. No. 34,994	Qualey, Terry	Reg. No. 25,148
Dalglish, Leslie E.	Reg. No. 40,579	Reich, John C.	Reg. No. 37,703
Daulton, Julie R.	Reg. No. 36,414	Reiland, Earl D.	Reg. No. 25,767
DeVries Smith, Katherine M.	Reg. No. 42,157	Samuels, Lisa A.	Reg. No. 43,080
DiPietro, Mark J.	Reg. No. 28,707	Schmaltz, David G.	Reg. No. 39,828
Edell, Robert T.	Reg. No. 20,187	Schuman, Mark D.	Reg. No. 31,197
Epp Ryan, Sandra	Reg. No. 39,667	Schumann, Michael D.	Reg. No. 30,422
Glance, Robert J.	Reg. No. 40,620	Scull, Timothy B.	Reg. No. 42,137
Goggin, Matthew J.	Reg. No. 44,125	Sebald, Gregory A.	Reg. No. 33,280
Golla, Charles E.	Reg. No. 26,896	Skoog, Mark T.	Reg. No. 40,178
Gorman, Alan G.	Reg. No. 38,472	Spellman, Steven J.	Reg. No. 45,124
Gould, John D.	Reg. No. 18,223	Stoll-DeBell, Kirstin L.	Reg. No. 43,164
Gregson, Richard	Reg. No. 41,804	Sumner, John P.	Reg. No. 29,114
Gresens, John J.	Reg. No. 33,112	Swenson, Erik G.	Reg. No. 45,147
Hammer, Samuel A.	Reg. No. P-46,754	Tellekson, David K.	Reg. No. 32,314
Hamre, Curtis B.	Reg. No. 29,165	Trembath, Jon R.	Reg. No. 38,344
Harrison, Kevin C.	Reg. No. P-46,759	Tuchman, Ido	Reg. No. 45,924
Hertzberg, Brett A.	Reg. No. 42,660	Underhill, Albert L.	Reg. No. 27,403
Hillson, Randall A.	Reg. No. 31,838	Vandenburgh, J. Derek	Reg. No. 32,179
Holzer, Jr., Richard J.	Reg. No. 42,668	Wahl, John R.	Reg. No. 33,044
Johnston, Scott W.	Reg. No. 39,721	Weaver, Karrie G.	Reg. No. 43,245
Kadievtch, Natalie D.	Reg. No. 34,196	Welter, Paul A.	Reg. No. 20,890
Karjeker, Shaukat	Reg. No. 34,049	Whipps, Brian	Reg. No. 43,261
Kastelic, Joseph M.	Reg. No. 37,160	Whitaker, John E.	Reg. No. 42,222
Kettelberger, Denise	Reg. No. 33,924	Wickhem, J. Scot	Reg. No. 41,376
Keys, Jeramie J.	Reg. No. 42,724	Williams, Douglas J.	Reg. No. 27,054
Knearl, Homer L.	Reg. No. 21,197	Withers, James D.	Reg. No. 40,376
Kowalchyk, Alan W.	Reg. No. 31,535	Witt, Jonelle	Reg. No. 41,980
Kowalchyk, Katherine M.	Reg. No. 36,848	Wu, Tong	Reg. No. 43,361
Lacy, Paul E.	Reg. No. 38,946	Xu, Min S.	Reg. No. 39,536
Larson, James A.	Reg. No. 40,443	Zeuli, Anthony R.	Reg. No. 45,255

I hereby authorize them to act and rely on instructions from and communicate directly with the person/assignee/attorney/firm/ organization who/which first sends/sent this case to them and by whom/which I hereby declare that I have consented after full disclosure to be represented unless/until I instruct Merchant & Gould P.C. to the contrary.

Please direct all correspondence in this case to Merchant & Gould P.C. at the address indicated below:

Merchant & Gould P.C.
P.O. Box 2903
Minneapolis, MN 55402-0903



I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

201	Full Name Of Inventor	Family Name CHUNG	First Given Name Chae	Second Given Name Hun
	Residence & Citizenship	City Kyungki-do	State or Foreign Country Republic of Korea	Country of Citizenship Republic of Korea
	Post Office Address	Post Office Address 402 Green Villa, 285-6 Sookwang-ri, Shindun-myun, Ichon-city	City Kyungki-do	State & Zip Code/Country Republic of Korea
Signature of Inventor 201:			Date:	

Table 1. Demographic characteristics of the study population	
Age (years)	Mean (SD)
Male	50.5 (10.5)
Female	51.5 (10.5)
Marital status	
Married	75.5%
Single	24.5%
Education (years)	Mean (SD)
Male	12.5 (2.5)
Female	12.5 (2.5)
Occupation	
Professional	35.5%
Managerial	25.5%
Technical	15.5%
Service	10.5%
Unemployed	12.5%
Income (US\$)	Mean (SD)
Male	1500 (500)
Female	1500 (500)
Health insurance	
Yes	85.5%
No	14.5%
Smoking status	
Smoker	25.5%
Non-smoker	74.5%
Alcohol consumption	
Yes	15.5%
No	84.5%
Family size	Mean (SD)
Male	3.5 (1.5)
Female	3.5 (1.5)
Urban/rural	
Urban	75.5%
Rural	24.5%

§ 1.56 Duty to disclose information material to patentability.

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclose information exists with respect to each pending claim until the claim is canceled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is canceled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclose all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§ 1.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine:

(1) prior art cited in search reports of a foreign patent office in a counterpart application, and

(2) the closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentably defines, to make sure that any material information contained therein is disclosed to the Office.

(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made of record in the application, and

(1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim;

(2) It refutes, or is inconsistent with, a position the applicant takes in:

(i) Opposing an argument of unpatentability relied on by the Office, or

(ii) Asserting an argument of patentability.

A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability.

(c) Individuals associated with the filing or prosecution of a patent application within the meaning of this section are:

(1) Each inventor named in the application:

(2) Each attorney or agent who prepares or prosecutes the application; and

(3) Every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application.

(d) Individuals other than the attorney, agent or inventor may comply with this section by disclosing information to the attorney, agent, or inventor.